REMARKS

These remarks are in response to the Final Office Action mailed May 7, 2003. Claims 98, 104-106, 108, 126, 128, 152, and 159 have been amended. No new matter is believe to have been introduced.

I. INTERVIEW SUMMARY UNDER 37 CFR §1.2, §1.133 and MPEP §713.04

Applicants would like to thank Examiner Soderquist for his time and insightful comments during the telephonic interview on August 22, 2003, with Applicants' representative, Joseph R. Baker.

The Examiner and Applicants' representative discussed certain claim amendments and the cited references under the 35 U.S.C. §103, discussed more fully below. No agreement was reached with respect to the allowance of the pending claims.

II. REJECTION UNDER 35 U.S.C. §112, SECOND PARAGRAPH

Claims 112, 123, and 159 stand rejected under 35 U.S.C. §112, second paragraph as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Applicants respectfully traverse this rejection.

The Examiner suggests amending claim 159 to recite, "wherein a plurality of sensors comprise at least two conductive leads and a sensing area comprising alternating interpenetrating regions of . . ." The Examiner indicates that such an amendment would clarify the above question and better lead into claims 112 and 123. Applicants have amended claim 159 as suggested by the

Examiner. Accordingly, Applicants respectfully request withdrawal of the §112, second paragraph rejection.

III. REJECTION UNDER 35 U.S.C. §103

Claims 98-110, 112-123, and 126-159 stand rejected under 35 U.S.C. §103 as allegedly unpatentable over Gibson in view of Casella, Thackeray, Yamato, Galal, Naarmann, Li (Materials Research Society Symposium Proceedings, 1995), Sakaguchi, Sestak, Torsi, or Wampler and Breheret, Mifsud (both USP 5,801,297 and WO 95/08113), Moy or Persaud (WO 86/01599). Applicants respectfully traverse this rejection.

A. The 37 C.F.R. §1.131 Declaration Filed March 4, 2003 Overcomes Sestak, Torsi, and Galal

The Office Action alleges that the §1.131 Declaration ("the 131 Declaration") filed March 4, 2003, is ineffective to overcome the Sestak et al., Torsi et al. and Galal references. The Office Action alleges that, ". . .the declaration is required to show that applicant had conceived of the compositions taught by the Sestak et al., Torsi et al., and Galal references." (See the Final Office Action at page 12, lines 21-23). Applicants respectfully traverse this allegation.

The Examiner is respectfully directed to the MPEP §715.02, which reads in part,

> Applicant may overcome a 35 U.S.C. 103 rejection based on a combination of references by showing completion of the invention by applicant prior to the effective date of any of the references; applicant need not antedate the references with the earliest filing date...applicant's 37 CFR 1.131 affidavit must show possession of either the whole invention as claimed or something falling within the claim(s) prior to the effective date of the references being antedated; it is not enough merely to show possession of what the reference happens to show if the reference does not teach the basic inventive concept.

Section 715.02 goes on to state,

> A reference or activity applied against a generic claims may (in most cases) be antedated as to such claims by an affidavit or declaration under 37 CFR 1.131 showing completion of the invention of only a single species, within the genus, prior to the effective date of the reference or activity.

Furthermore, an applicant may use a 37 C.F.R. §1.131 Declaration to pre-date what the reference shows by showing either: (i) the same species or (ii) an obvious variant of the reference species (*In re Schaub*, 537 F.2d 509 (CCPA 1976)).

Applicants submit that the 131 Declaration shows CB (carbon black) and PANI (polyaniline) composites, a species encompassed by independent claims 98, 104-106, 108, 126-128, 148, and 152. This shows a completion of Applicant's claimed invention prior to the cited references.

Furthermore, attached hereto as Exhibit A is a reference (Gábor Harsányi, Ph.D., "Polymer Films in Sensor Applications," 1995, Technomic Publishing Company, Inc., pp. 113-114) showing the carbon black and such metals as gold, silver, and the like are common conductive fillers that are interchangeably used. The attached reference pages are cummulative to references already of record including Lewis et al. (USP 5,571,401). Both the cited reference pages and the '401 patent teach insulators with conductive fillers.

Thus, Applicants submit that the 131 Declaration filed March 4, 2003, satisfies each of these criteria set forth in the MPEP and in the case-law, and thus is effective to overcome Sestak et al., Torsi et al., and Galal.

Accordingly, Sestak et al., Torsi et al., and Galal are not prior art to Applicants' claimed invention. This leaves only the following references to be addressed: Gibson, Casella,

Thackeray, Yamato, Naarmann, Li, Sakaguchi, Wampler, Breheret, Mifsud, Moy and Persaud.

B. Electrochemical Sensors Do Not Meet The Elements Of Applicants' Claimed Invention And There Is No Motivation To Combine Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li

With respect to Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li, Applicants maintain that Casella, Thackeray, Yamato, Galal, Naarmann, and Li are fundamentally different sensor systems and one of skill in the art would not look to these sensor systems in developing a chemoresistive-type sensors as disclosed and claimed by Applicants. Even if there was some motivation to combine, which there is not, the references cited do not teach or suggest each and every element of Applicants' claimed invention. For example, the electrochemical systems of the cited references utilizes a single conductive lead attached to the sensing material, not two leads as recited in Applicants' claims. As suggested by the Examiner in the telephonic interview, Applicants have amended claim 98, 104-106, 108, 126, 128, and 152, to further specify the relationship of the conductive leads and sensing materials of Applicants' claimed invention. The claims now set forth that the conductive leads are in contact with the sensing area.

Furthermore, the electrochemical systems are based upon redox reactions, which are fundamentally different than resistance measurements as recited in Applicants' claims. The electrochemical sensors do not measure changes "across" the sensor material as recited in Applicants' claimed invention.

1. The Cited References Do Not Teach Or Suggest Each And Every Element Of Applicants' Claimed Invention

Casella teaches a sensor layered with polyaniline. The Casella sensor measurements are done using an electrochemical system (see Exhibit A of prior response filed February 24, 2003). For example, Casella teaches at page 218, §2.2 "Apparatus", that "[c]yclic voltammetry (CV) was done in a *three-electrode cell* using a Cu-PANI working electrode, a saturated colomel reference electrode (SCE) . . . and a platinum foil counter electrode." As such the Casella sensor has only a single conductive lead and measures redox reactions upon the sensor material. Casella does not teach or suggest the elements of Applicants' claimed invention (e.g., two conductive leads, and changes of resistance).

Thackeray et al. is electrochemical in nature, requiring an electrolyte media containing ions to maintain a potential on the sensor. The electrochemical reaction involves a transfer of faradic charge and associated ions between the sensor of Thackeray et al. and the phase containing the analyte to be sensed. Thus, a vapor cannot be in direct contact with the sensor of Thackeray et al. for the sensor of Thackeray et al. to function as intended. The sensors of Thackeray et al. measure a change in redox at the sensor interface with the electrolyte medium.

Yamato et al. teaches a sensor for electrochemical measurements. The sensor material of Yamato et al. is utilized in a "*three-electrode cell* containing 5 ml of 0.1 M KCl/0.1 M phosphate buffer (PB, pH 7.5) solution." (see page 232, §2.4 "Measurements"). As such the Yamato et al. sensor has only a single conductive lead and measures a change in redox at the

sensor interface with the electrolyte medium. Yamato et al. do not teach or suggest two conductive leads attached to a sensor as recited in Applicants' claims. Yamato et al. do not teach or suggest resistivity measurements as recited in Applicants' claims.

Galal utilizes an electrochemical sensor system (i.e., "*three electrodes*, Pt, PMT, and PMT/Fc"; see page 9, col. 1, lines 12-13). For example, in the sensor system of Galal 0.1 M H_2SO_4 and phosphate buffer, pH 6.7, were used (see, e.g., page 9, col. 2, lines 15-16). Thus, a vapor analyte was not in direct contact with the sensor. In addition, the sensors of Galal only require a standard single conductive lead, characteristic of electrochemical systems. Galal does not teach or suggest two conductive leads attached to a sensor as recited in Applicants' claims. Galal does not teach or suggest resistivity measurements as recited in Applicants' claims.

Naarmann also teaches electrochemical systems. For example, Naarmann teaches that the electrochemical polymer material can be used as an electrode or electrodes in electrochemical storage cells (see English Abstract).

Li (Materials Research Society Symposium Proceedings, 1995) also teaches electrochemical sensors (i.e., sensor that comprise a single conductive lead). For example, at page 583-584, Li shows the use of a PANI-Pd film as an electrode (e.g. a cathode/anode) in an electrochemical cell. Li does not teach or suggest a sensor comprising two conductive leads that undergo a measurable change due to adsorption or absorption of an analyte.

Accordingly, each of the foregoing reference clearly fails to teach each and every element of Applicants' claimed invention. This is applicable to the individual references, as well as the combination of each of the foregoing reference. All

the foregoing references fail for the at least the foregoing same reasons.

2. No Motivation To Combine Electrochemical Sensors With Resistivity Sensors

Applicants respectfully remind the Examiner that the motivation to combine references must be shown prior to Applicants' conception date for the invention. Here the Examiner is relying upon a reference (Sestak) for showing a motivation to combine, which is after Applicants' conception date.

Applicants submitted in the prior response filed February 24, 2003, that Sestak (which is not prior art to the present invention; see the 131 Declaration above) provides that those of skill in the art, even after Applicants' conception date, recognized the difficulties of electrochemical sensors. Sestak provides evidence that one of skill in the art would not look to the electrochemical sensors of Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li to arrive at the combination suggested by the Examiner. Sestak states:

> Conducting polymer-based sensors utilise electrochemical methods for detection, wherein the polymer acts as an electrode, or alternatively, they are based on simple resistometric detection. *The former can have the disadvantage of poor stability* due to polymer degradation, usually caused by over-oxidation occurring during electrochemical cycling.

(See page 118, 2nd full paragraph under the "Introduction"; emphasis added). The Examiner cites to the third sentence of this paragraph and the paragraph bridging pages 118-119, for the alleged teaching that resistance-type sensors are taught. However, the point Applicants are making is that one of skill in

the art would not have looked to electrochemical-type sensors, such as those taught by Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li at the time Applicants conceived of the invention, which predates Sestak (as discussed above). This is supported by Sestak in the statement quoted above and further supported by the fact that Applicants' claimed invention does not require a charger transfer system and thus can sense analytes that the electrochemical approach cannot. Because of the fundamentally different measurements and reactivity of the two different types of sensors one of skill in the art would not look to a system that requires redox reactions and single conductive leads in developing sensors that measure a resistance between two conductive leads separated by the sensing area. One of skill in the art would not combine the electrochemical sensor references (e.g., Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li) with those teaching chemoresistive-type sensors. It would not be inherent or obvious that the sensor material used in electrochemical systems would function in the sensor systems as set forth by Applicants. For example, a pH electrode is an electrochemical sensor system. One of skill in the art would not look to or expect that a pH sensor can be combined with other references to arrive at Applicants' invention. Furthermore, Applicants submit that materials used in electrochemical sensor systems are not required to be conductive (i.e., such systems utilize materials that are non-conductive), which is contrary to Applicants' claimed invention.

The Examiner directs Applicants to reference 8 of Sestak (i.e., Li; cited herein) as showing a motivation to combine references. Applicants submit that the motivation is found in a reference (Sestak) that is after Applicants' conception date and therefore is inapplicable.

Thus, Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li do not teach each and every element of Applicants' claimed invention. The references fail to teach or suggest resistance measurements and a sensing area separated by and in communication with two conductive leads. Furthermore, one of skill in the art would not look to the teachings of Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li as the sensor systems of these references utilize redox reactions (fundamentally different than resistance measurements) and require a different over all system of detecting an analyte compared to Applicants' claimed invention. Applicants submit that there is no motivation to combine these references to arrive at Applicants' invention.

Accordingly, Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li do not render the invention obvious for at least the foregoing reasons, and Sestak et al., Torsi et al., and Galal are not prior art as discussed above. This then leaves the following references: Gibson, Sakaguchi, Wampler, Breheret, Mifsud, Moy and Persaud.

C. Gibson, Sakaguchi, Wampler, Breheret, Mifsud, Moy And Persaud Do Not Teach Or Suggest Applicants' Invention Alone Or In Combination

The Examiner agrees the Gibson as the primary reference does not anticipate the claims. However, the Examiner alleges that the "monomers" disclosed in Gibson are considered compositionally different materials for the purposes of Applicants' claimed invention. Applicants respectfully traverse this rejection.

1. Gibson Does Not Teach Two Different Conductive Materials

The Office Action alleges that page 12 of Gibson teaches a material having two different monomers used to form a copolymer, which the examiner is treating as within the scope of two different conducting materials. Applicants respectfully disagree that the polymers of Gibson are within the scope of two compositionally different conductive materials.

Applicants respectfully submit that two monomers when reacted together do not form two "compositionally different" materials. The two monomers are reacted together to become a polymer that is a single material the cannot be separated into two monomeric materials. Furthermore, a polymer has physical-chemical properties specific for the polymer not the monomers. This is a fundamental principle of chemistry. When two monomers are reacted to become a polymer, the conductive properties of the polymer are not the conductivity of each monomer but are the physical-chemical (i.e., conductive) properties of *the polymer, not the monomers*. In contrast, Applicants' claims recite that the conductive materials are compositionally different. For example, gold has conductive properties that are independent of the conductive properties of a conducting polymer (e.g., polythiophene).

2. Gibson Does Not Teach Or Suggest Materials Comprising Non-Organic Polymers

The Office Action states at page 3, lines 13-16, "Gibson does not teach . . .two materials . . .mixed together to form as a single sensing material having the compositionally different conductive material within the conductive organic material or as a sensing array having sensors that are not organic polymer

based." This quotation from the Office Action and by the Examiners admission clearly indicates that Gibson does not teach or suggest Applicants' claimed invention.

a. Gibson does not teach or suggest a single sensing material having a compositionally different material within the conductive organic material

Applicants' independent claims (e.g., see claim 98) recite:

> . . .a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

The Examiner agrees at page 3 of the Final Office Action that Gibson does not teach or suggest such a sensing area as set forth in the foregoing element of Applicants' claims.

b. Gibson teaches and suggests a sensor that is only organic polymer based

Applicants submit that Gibson does not teach or suggest a compositionally different conductive material:

> . . .selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof. . .

The Examiner agrees at page 3 of the Final Office Action that Gibson does not teach or suggest such "[non]-organic polymer based" sensors.

Furthermore, Applicants submit that Gibson fails to teach or suggest a compositionally different material:

> . . .wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases. .

Thus, Gibson alone does not teach or suggest Applicants' claimed invention as the Gibson reference does not teach or suggest each and every element of Applicants' claimed invention. Accordingly, the Office Action attempt to combine additional references with Gibson in order to overcome the deficiencies of Gibson.

3. Gibson And Casella Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. The Casella reference teaches an electrochemical sensor as described above and thus one of skill in the art would not look to Casella to overcome the deficiencies of Gibson. The Casella reference does not teach or suggest two conductive leads or that a vapor is in direct conduct with a sensor. The electrode of Casella containing the copper/polyaniline absorbs or releases electrons thereby changing electron flow between the cathode and anode. The combination of Gibson, which does not teach a single sensing area between two conductive leads, is combined with Casella, which also does not teach a single sensing area comprising two compositionallly different materials between two conductive

leads. Thus, both Gibson and Casella fail to teach or suggest the following element of Applicants' claims:

> . . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material, and wherein the sensing area is in direct contact with a vapor comprising an analyte to be detected

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

4. Gibson And de Lacy Costello Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention as discussed above. De Lacy Costello is combined with Gibson to overcome the deficiencies of Gibson. However, the combination of Gibson and de Lacy Costello fails to teach or suggest the temperature/conductivity characteristics of Applicants claimed invention. For example, both Gibson and de Lacy Costello fail to teach or suggest:

> . . .wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases.. .

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

5. Gibson And Thackeray Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Thackeray teaches an electrochemical sensor as described above and thus one of skill in the art would not look to Thackeray to overcome the deficiencies of Gibson. The chemistry that produces a signal in Thackeray is electrochemical in nature, requiring an electrolyte media containing ions to maintain a potential on the sensor. The electrochemical reaction involves a transfer of faradic charge and associated ions between the sensor of Thackeray and the phase containing the analyte to be sensed. Thus, a vapor is not in direct contact with the sensor of Thackeray. In the prior Office Action mailed October 23, 2002, the Examiner addresses Applicants' arguments by stating that, "The Thackeray reference is clearly sensitive to gases - hydrogen and oxygen." (See, e.g., page 12 of the October 23, Office Action). Applicants respectfully submit that Thackeray is sensitive to hydrogens and oxygen atoms because REDOX reactions are the basis of how the sensor system of Thackeray works. Applicants respectfully submit that the sensors of Thackeray et al. would cease to function if they were directed contacted with a vapor containing an analyte because the Thackeray et al. sensors would be unable to perform REDOX reactions.

Thackeray does not teach or suggest that an analyte is capable of adsorbing or absorbing to the sensor material. The sensor material of Thackeray is sensitive to changes in electrons in the electrolyte medium (i.e., oxidation or reduction due to the presence of hydrogen or oxygen). The combination of Gibson, which does not teach a single sensing

area between two conductive leads, is combined with Thackeray, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. Thus, both Gibson and Thackeray fail to teach or suggest the following element of Applicants' claims:

> . . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in electrical communication with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

6. Gibson And Yamato Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Yamato et al. teach sensors having on their surface glucose oxidase (GOD) (see, Yamato at page 235, first column, section 3.2). Applicants submit that an enzyme linked electrochemical (oxidation reduction) system is far removed from Applicants' claimed invention and thus one of skill in the art would not look to Yamato to overcome the deficiencies of Gibson.

Applicants submit that even if there were motivation to combine Gibson and Yamato, which there is not, at most the combination would teach the use of immobilized enzymes (very different than conductive materials) on a polymer material for use in an electrochemical system (e.g., having only a single

conductive lead). The combination of Gibson, which does not teach a single sensing area between two conductive leads, is combined with Yamato, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. As such Yamato in combination with Gibson would fail to teach or suggest:

> . . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in electrical communication with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

7. Gibson And Galal Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Galal is not prior art to the claimed invention and thus cannot be combined for purposes of obviousness. However, even if Galal is combined with Gibson the combination fails to teach or suggest Applicants' claimed invention.

Galal utilizes an electrochemical sensor system (i.e., "three electrodes, Pt, PMT, and PMT/Fc"; see page 9, col. 1, lines 12-13). For example, in the sensor system of Galal 0.1 M H2SO4 and phosphate buffer, pH 6.7, were used (see, e.g., page

9, col. 2, lines 15-16). Thus, a vapor analyte was not in direct contact with the sensor. In addition, the sensors of Galal only require a standard single conductive lead, characteristic of electrochemical systems. The combination of Gibson, which does not teach a single sensing area between two conductive leads, is combined with Galal, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. Thus, both Gibson and Galal fail to teach or suggest the following element of Applicants' claims:

> . . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in electrical communication with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

8. Gibson And Naarmann Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Naarmann is combined with Gibson fails to teach or suggest Applicants' claimed invention.

Naarmann teaches that the electrochemical polymer material can be used as an electrode or as sensor electrodes in electrochemical storage cells (see English Abstract). The

combination of Gibson, which does not teach a single sensing area between two conductive leads, is combined with Naarmann, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. Thus, both Gibson and Naarmann fail to teach or suggest the following element of Applicants' claims:

> . . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

In addition, Gibson in combination with Naarmann also fails to teach or suggest the following element of Applicant's claimed inventino, namely,

> . . .selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof. . .

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

9. Gibson And Li Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Li also teaches electrochemical sensors (i.e., sensors that have a single conductive lead). For example, at page 583-584, Li shows the use of a PANI-Pd film as an electrode (e.g. a cathode/anode) in

an electrochemical cell. Li does not teach or suggest a sensor comprising two conductive leads that undergo a measurable change due to adsorption or absorption of an analyte. The combination of Gibson, which does not teach a single sensing area between two conductive leads, is combined with Li, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. Thus, both Gibson and Li fail to teach or suggest the following element of Applicants' claims:

> . . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

10. Gibson And Sakaguchi Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Sakaguchi also teaches electrode (e.g. a cathode/anode) reactions (see, e.g., page 7, line 11-12 of the Final Office Action). Such electrode reactions are used in electrochemical cells. Sakaguchi does not teach or suggest a sensor comprising two conductive leads that undergo a measurable change due to adsorption or absorption of an analyte. The combination of Gibson, which does not teach a single sensing area between two conductive leads, is combined with Sakaguchi, which also does not teach a single sensing area

comprising two compositionally different conductive materials between two conductive leads. Thus, both Gibson and Sakaguchi fail to teach or suggest the following element of Applicants' claims:

> . . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

11. Gibson And Sestak Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Sestak is not prior art to the claimed invention and thus cannot be combined for purposes of obviousness.

12. Gibson And Torsi Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Torsi is not prior art to the claimed invention and thus cannot be combined for purposes of obviousness.

13. Gibson And Wampler Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Gibson is further combined with Wampler in an attempt to overcome the deficiencies of Gibson. Wampler teaches that polypyrrole composites are useful for eliminating Cr(VI) in the environment by reducing Cr(VI) to Cr(III) (see, e.g., page 1820). Wampler, however, does not teach or suggest composites as chemoresistive-type sensors comprising a sensing area separating two electrical leads that measure a change in the electrical properties of the composite between the two leads when contacted with an analyte. Thus, the combination of Gibson, which does not teach a single sensing area between two conductive leads, is combined with Wampler, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. The combination of Gibson and Wampler fails to teach or suggest:

> . . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

14. Gibson And Breheret Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson is also combined with Breheret. Breheret mentions two different types of sensors: 1) semiconductor gas sensors, and 2) conducting polymer sensors. Neither of the two types of sensors is described nor does Breheret teach or suggest the composition of the sensors. The only description found in the Breheret reference is to the "AROMASCAN A20S Device". Applicants respectfully submit that the Breheret reference is not enabled for any teaching relied upon by the Examiner to render Applicants' invention obvious. For example, there is no teaching or suggestion in Breheret that overcomes the deficiencies of Gibson. In other words, the combination fails to teach or suggest:

> . . .a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

The combination fails to teach or suggest:

> . . .selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof. . .

Furthermore, Applicants submit that the combination fails to teach or suggest a compositionally different material:

> . . .wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases. .

However, even if the Breheret reference was enabled, Breheret teaches away from Applicants' claimed invention due to the teaching that such polymer films are less sensitive than semiconductive gas sensors. This is in contrast to the unexpected finding presented in Applicants' disclosures which teaches that the conductive organic polymers and compositionally different conductive material composites have orders of magnitude better sensitivity than other conventional polymer composites to amine analytes. Accordingly, the combination of Gibson and Breheret fails to teach or suggest each and every element of Applicants' claimed invention.

By law the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

15. Gibson And Mifsud Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson is also combined with Mifsud. Mifsud does not teach or suggest the composition of the sensors. Applicants respectfully submit that the Mifsud reference is not enabled for any teaching relied upon by the Examiner to render Applicants' invention obvious. For example, there is no teaching or suggestion in Mifsud that overcomes the deficiencies of Gibson. In other words, the combination fails to teach or suggest:

> . . .a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the

> conductive organic material and the regions of the compositionally different conductive material. . .

The combination fails to teach or suggest:

> . . .selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof. . .

Furthermore, Applicants submit that the combination fails to teach or suggest a compositionally different material:

> . . .wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases. .

The only teaching that would allow a person skilled in the art to have the faintest idea as to the composition of the conductive polymer sensors is found at column 1, lines 53-64, which teaches that the conductive polymer sensors "have a film made of a conductive polymer sensitive to the molecules of odorous substances." Mifsud fails to teach or suggest a sensing area of a conductive organic polymer and a compositionally different conductive material.

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

16. Gibson And Moy Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson is also combined with Moy. Moy does not teach or suggest the composition of the sensors. Applicants respectfully

submit that the Moy reference is not enabled for any teaching relied upon by the Examiner to render Applicants' invention obvious. For example, the Moy reference does not teach or suggest a composite of a metal oxide and a polymer. Rather, Moy allegedly teaches an array made up of one or more metal oxide sensors and one or more polymer sensors. There is no teaching or suggestion in Moy that overcomes the deficiencies of Gibson. In other words, the combination fails to teach or suggest:

> . . .a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

The combination fails to teach or suggest:

> . . .selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof. . .

Furthermore, Applicants submit that the combination fails to teach or suggest a compositionally different material:

> . . .wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases. .

Applicants respectfully submit that Moy fails for the same reasoning as presented for Breheret and Mifsud above. The Moy reference does not teach or suggest any polymer materials used in the "polymer sensors". Moy teaches at most an array of (1) metal oxide gas sensors and (2) sensors having a conductive polymer. Moy does not teach or suggest a sensor comprising a

composite having both a conductive organic material and a compositionally different conductive material. Nor does Moy teach or suggest an array of sensors, wherein at least one sensor comprises a material having both a conductive organic material and a compositionally different conductive material. Thus, the combination of Gibson and Moy does not teach or suggest Applicants' claimed invention.

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

17. Gibson And Persaud Do Not Teach Or Suggest Applicants' Claimed Invention

Gibson is addressed above and is deficient (as admitted by the Examiner) in that Gibson fails to teach or suggest a composite of a conducting organic material and a conducting material that is compositionally different. Applicants respectfully submit that Persaud fails for the same reasoning as presented for Breheret, Mifsud, and Moy, above. Persaud teaches as most a sensor having an organic polymeric semiconductor such as polyindole (see, e.g., page 4, line 2). Persaud does not teach or suggest a sensor having a sensing area comprised of a combination of a conductive organic material and a compositionally different conductive material.

> . . .a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the

> conductive organic material and the regions of the compositionally different conductive material. . .

Nor does Persaud teach or suggest an array of sensor, wherein at least one sensor comprises a material having both a conductive organic material and a compositionally different conductive material. Thus, the combination of Gibson and Moy does not teach or suggest Applicants' claimed invention.

Accordingly, by law, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

To briefly summarize this response, Gibson admittedly does not teach or suggest each and every element of Applicants' claimed invention. For example, Gibson does not teach or suggest a single sensing area comprising two compositionally different conductive materials between two conductive leads as recited in Applicants' independent claims. The remaining references fail to overcome this deficiency. Sestak et al., Torsi et al. and Galal are unavailable as prior art to Applicants' claimed invention. In addition, Casella, Thackeray, Yamato, Galal, Naarmann, and Li teach and suggest fundamentally different sensor systems and one of skill in the art would not look to these sensor systems in developing a chemoresistive-type sensors as disclosed and claimed by Applicants.

Applicant asks that all claims be allowed. Enclosed is a $110 check for the Petition for Extension of Time fee. Please apply any charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

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POLYMER FILMS in SENSOR APPLICATIONS

TECHNOLOGY, MATERIALS, DEVICES AND THEIR CHARACTERISTICS

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TECHNOMIC PUBLISHING CO., INC.
LANCASTER · BASEL

Polymer Films in Sensor Applications
a TECHNOMIC publication

Published in the Western Hemisphere by
Technomic Publishing Company, Inc.
851 New Holland Avenue, Box 3535
Lancaster, Pennsylvania 17604 U.S.A.

Distributed in the Rest of the World by
Technomic Publishing AG
Missionsstrasse 44
CH-4055 Basel, Switzerland

Printed in the United States of America
10 9 8 7 6 5 4 3 2

Main entry under title:
Polymer Films in Sensor Applications: Technology, Materials, Devices and Their Characteristics

A Technomic Publishing Company book
Bibliography: p.
Includes index p. 425

Library of Congress Catalog Card No. 94-61559
ISBN No. 1-56676-201-4

this polymer, the organic residue consists of the molecular group $-CH_2-CH_2-CH_2-N(CH_3)_3$, which acts as an adsorption centre for SO_2. Interdigital capacitors applying this type of dielectric layers show relatively big capacitance changes when exposed to a 0–200 vpm SO_2 concentration in the air.

Reversible changes of thickness due to swelling of polymers have also been measured by capacitance variations. The largest effect was found at poly(cyanopropylmethylsiloxane) in an atmosphere containing *n*-hexane or ethanol [29]. It is interesting that different sensing mechanisms were found at the two materials. While *n*-hexane causes a clean swelling effect with a sensitivity of $1.3 \cdot 10^{-4}$ μm/Pa, which is resulted from the interaction with the polar Si–O bonds in the polymer, ethanol, in contrast, alters the permittivity of the layer due to the additional contribution from the permanent dipole moment of the OH group.

The latter type behaviour was also found at different conventional (carbon-based) polymers interacting with strong polar organic molecules. For example, a capacitance change of 20% can be observed at poly(ethylene glycol) layers when the partial pressure of dimethylformamide is 152 Pa [29].

3.2 SENSING EFFECTS IN CONDUCTIVE POLYMER COMPOSITES

Electrically conducting or semiconducting polymers have attracted a great deal of interest applied as sensing layers in sensors. There are two types of conducting polymers:

(1) Polymers that are intrinsically conducting or can be made so by doping
(2) Composites that contain an electrically insulating polymer matrix loaded with a conductive filler

In this section the behaviour of the latter type conductive polymers will be discussed.

The bulk materials are known in practice as conductive rubbers. Composite films can be fabricated by spin coating, by thick-film, and by thin-film technologies. A number of precursors are known as polymer thick-film (PTF) pastes. Their physical and chemical properties are similar to those of CERMET thick films (see Sections 1.3.2 and 1.3.3). Thin-film composites are deposited by simultaneous evaporation or RF sputtering of metals and polymers. The often used filler materials are metals (Cu, Pd, Au, Pt), carbon black, and semiconducting metal-oxides (V_2O_5, TiO_2, etc.). The

most important polymers that can be used as matrices are: polyethylene, polyimides, polyesters, poly(vinyl acetate) (PVAc), PTFE, polyurethane, poly(vinyl alcohol) (PVA), epoxies and acrylics, e.g., poly(methyl methacrylate).

3.2.1 Theory of the Conduction Mechanism

In order to understand the electrical behaviour of polymer composites, it is necessary to give a short summary about the conduction models. The concept of percolation [30] can be used to understand the change in sensitivity as a function of filler concentration in metal-insulator composites. The percolation threshold is defined as the filler volume fraction at which the resistivity begins to decrease. For low filler concentrations, it is basically equal to the resistivity of the polymer matrix (see Figure 3.11). The critical threshold, v_c, is associated with the concentration at which the filler particles begin to form conductive paths. As it is increased further, more conductive paths are created through the composite, resulting in a resistivity drop by several orders of magnitude. Above v_c the function is saturated, and the resistivity approaches monotonously the resistivity of the conducting phase. Typical percolation curves are shown in Figure 3.12 [30].

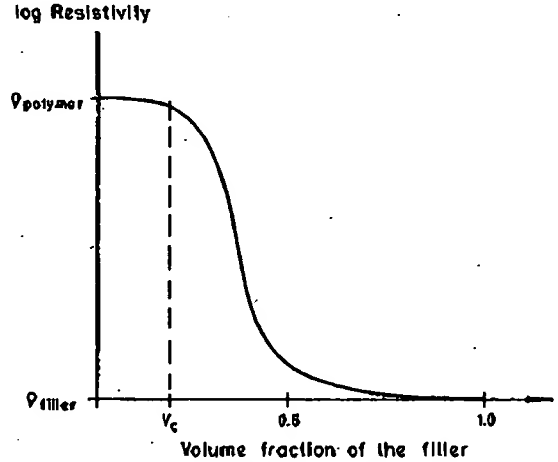

FIGURE 3.11. Effective electrical resistivity for a composite conductor as a function of the filler volume fraction.

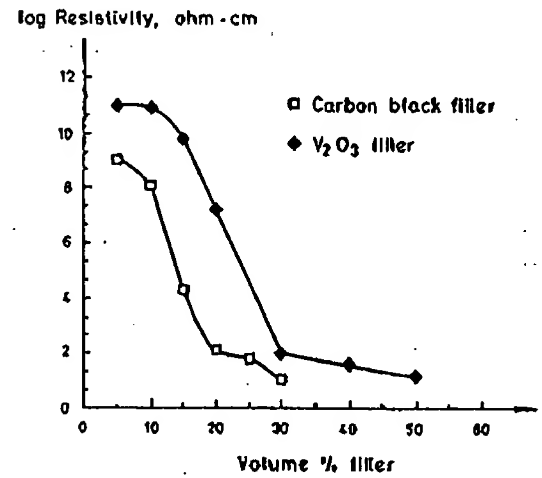

FIGURE 3.12. Percolation curves for polyethylene composites. (Redrawn from the data of Ruschau et al. [30], with the kind permission of Elsevier Sequoia S. A., Lausanne, Switzerland, publisher of *Sensors and Actuators A* and *Sensors and Actuators B*.)

A detailed theoretical description of the conduction mechanism in composite conductors is based on several effects: percolation, quantum mechanical tunneling between the conducting particles, and thermally activated hopping of electrons through localized deep energy levels in the band gap of the polymer matrix, and in some cases, field emission may also be supposed [31]. Percolation always dominates the resistivity when the filler concentration is far above v_c. If it is comparable to or smaller than v_c, tunneling and hopping have important consequences. The extra current provided by this mechanism decreases the resistivity relative to the case of pure percolation, but the amount is very sensitive to the temperature, the composition, a number of geometrical factors, and environmental effects that influence the current density between conductive particles.

The transmission-probability, P, of electrons through an energy barrier of height, W_0, and width, a (which is also the mean distance between neighbouring conductive grains) is (see Figure 3.13)

$$P \propto \exp\left[-\frac{4\cdot\pi\cdot a}{h}\cdot(2\cdot m_e\cdot W_0)^{1/2}\right] \qquad (3.15)$$